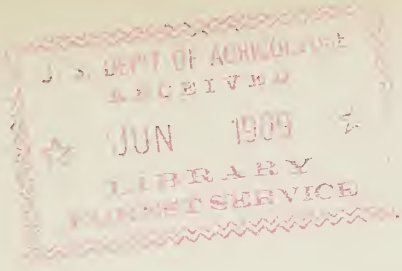

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IMPROVEMENT OF THE OAT CROP.

BY

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IMPROVEMENT OF THE OAT CROP.[a]

NEED FOR IMPROVEMENT.

Nearly 32,000,000 acres were devoted to the production of oats in the United States in 1907. This was the largest acreage reported up to that time, but the acre yield was the lowest since 1893 and among the lowest recorded by the Bureau of Statistics of the United States Department of Agriculture. The quality in the principal oat-producing sections was also very poor. The acreage in 1908 was approximately the same as that of the previous year, and though the crop was slightly larger than in 1907, yet it was far below the average of the previous ten years. When the average yield of oats for the United States is as low as 25 bushels to the acre, as it has been in the past two years, it is evident that improved varieties and better methods of growing and handling the crop are much needed. Only the improvement of the crop as effected through the seed will be discussed here.

[a] The low yield and poor quality of the oat crop over a large portion of the United States in 1907 and 1908 leave no doubt of the need for the improvement of this cereal. Much attention has been given to the selection and improvement of corn in the last ten years; agricultural papers have been filled with suggestions of methods and details of results; numerous bulletins on the subject have been published by the agricultural experiment stations; farmers' institute lectures have been devoted to it; and in many States "seed-corn trains" have been run on prominent railroad lines. Strangely enough, with all this enthusiasm and the actual improvement of the corn crop which has resulted, farmers have given little attention to the breeding of other cereals. Recently there has been some general discussion as to methods of improving them, but the subject is still one which is little understood by farmers, and for that reason the present paper has been prepared.

The method of improvement by individual plant selections recommended by the author has been used with much success by European and American small-grain breeders for years, and as here outlined is now used by a number of experiment stations as well as on the experimental farms of the Office of Grain Investigations of this Bureau.—B. T. Galloway, *Physiologist and Pathologist, and Chief of Bureau.*

LINES ALONG WHICH IMPROVEMENT CAN BE EFFECTED.

The prominent lines along which the oat crop can be improved are the yield, ratio of kernel to hull, and weight per bushel. Incidentally, selection may be made for strength of straw, resistance to disease, and earliness, though all these points usually contribute to the increase in yield. For cereal manufacture a high ratio of kernel to hull is desirable, and this may be made the basis of selection. Generally speaking, selection will be made for increased yield, with incidental reference to lodging and disease resistance, and to time of maturity.

METHODS OF IMPROVEMENT.

Several methods of attaining the desired end in the improvement of any small-grain crop may be suggested. These are: Mechanical selection; introduction of new seed; use of the seed plat; individual plant or head selection, and hybridization.

MECHANICAL SELECTION.

Much has been said and written about the use of the fanning mill and other means of seed separation by gravity or wind power for the improvement of seed oats. Actual field tests carefully conducted by several experiment stations indicate that little permanent improvement of the variety results from these methods of selection. If the seed is carefully cleaned each year, however, the work will be fully justified by the removal of weed seed and the small shriveled grain, which, if it grew at all, would probably produce weak and unproductive plants. The ordinary field crop of oats is a mixture of several varieties, some of which are necessarily inferior. Mechanical selection can not, of course, purify the strain by the removal of these mixtures, which are often the cause of unsatisfactory returns. This can be accomplished only by hand selection.

INTRODUCTION OF NEW SEED.

The introduction of new seed includes importations from foreign countries and transfer from one locality to another within the United States. Many of our best varieties have been introduced from foreign countries; indeed, it is probably true that more good varieties of oats have been introduced from abroad, especially from Europe, than of any other cereal. This is largely due, however, to the fact that little attention has been given to the production of new varieties of oats in the United States. Notable among the introductions of recent years have been Swedish Select and Sixty-Day, introduced by the United States Department of Agriculture, and Kher-

son, introduced by the Nebraska Agricultural Experiment Station. While much has been done in this line in the past, we can not depend entirely on this source for the future, as we have practically exhausted the list of existing varieties in Europe, and highly specialized varieties bred there are unlikely to succeed over any large area of the United States. The selection and improvement of those varieties already introduced which have proved of value can best be carried on in our own country in the sections to which they are adapted.

Little permanent improvement can be secured by the exchange of seed from one locality to another. A variety which does well in one State or section will not necessarily succeed in another, even though conditions are apparently similar, whereas the general tendency is to make these transfers between localities with greatly varying conditions of soil and climate. The transfer of plump, heavy grain grown under irrigation in Montana can hardly be attended with success when the succeeding crop is grown under the very different conditions of Iowa or Illinois. Experiments now being made by the Office of Grain Investigations of this Bureau indicate that home-grown seed of a given variety will in general outyield that from a distance, even where the original stock is the same. At Amarillo, Tex., home-grown seed of Burt oats yielded practically twice as much as an adjoining plat of the same variety from seed which had been grown in central Kansas for two years, though both lots were grown from the same original stock. Where improved high-yielding varieties can be secured from near-by growers, their purchase to replace common or inferior stock is to be recommended, but it is not advisable to secure seed oats from a section in which the conditions are widely different from those under which the crop is to be grown.

USE OF THE SEED PLAT.

A practical method of improving the oat crop, though one which involves some time and expense, is the use of the small seed plat. This requires the selection of a considerable quantity of good heads from the field after the grain matures, and just before it is harvested. Care should be exercised in selecting the heads, so as to get them as nearly as possible of one type. Only plants which show superior qualities under ordinary conditions should be selected. Those which stand alone, near the edge of the field, or which are otherwise especially favored, should be rejected. The heads selected should be thrashed by hand and the grain secured should be sown on a plat of well-prepared land the following spring. The crop should be harvested and thrashed separately from the main crop. At thrash-

ing, the first portion to go through the machine should be rejected, as it is likely to contain a mixture of other grain. The grain from the seed plat should be used the succeeding year for sowing the general crop, or such portion of it as the quantity of seed secured makes possible.

To effect permanent improvement, the best heads should be selected from the seed plat at each harvest to plant the seed plat of the next year. The quantity selected will, of course, vary with the size of the seed plat desired. If possible this should be large enough to furnish seed for the general crop of the following year. Where the acreage is considerable, another year is required for the transfer from the seed plat to the general crop. For instance, enough heads are selected the first season to make one bushel of seed. This is sown on a half acre and produces 25 bushels. The 25 bushels will sow 10 to 12 acres the following year, which should produce enough to sow several hundred acres the succeeding year. The length of time from seed plat to general crop will, of course, depend on the ratio of size of the small plat to the acreage of the general crop.

The term "seed plat" is sometimes used to designate the plat or small field in which new or desirable varieties are increased until sufficient seed is secured for the field crop. Thus, if a seed grower or dealer or an experiment station in the vicinity has a good strain which the farmer wishes to try, it can be sown in this trial or seed plat, and if it proves better under his conditions than his general crop it can be increased sufficiently in a year or two to take the place of the old variety in the field. The use of the seed plat in this way is often advisable, as it offers an opportunity to test the new variety on a small scale without risking the entire crop. Frequently, too, seed of new varieties can not be secured in sufficient quantity, or is too high in price, for the sowing of large fields, and an increase plat is thus made a necessity.

INDIVIDUAL PLANT SELECTION.

The most reliable and, at the same time, the slowest means of improvement is by the selection of individual plants and the establishment of pedigreed strains. Individual heads should be selected from the field crop as for the seed plat, but, instead of bulking the seed when thrashed, the seed from the several heads should be planted in separate rows. An excellent method of testing these selections has been described by Mr. J. B. Norton,[a] formerly in charge of the

[a] American Breeders' Association, vol. 3, pp. 280–285. This plan is outlined rather more in detail by H. J. Webber in Cornell University Agricultural Experiment Station Bulletin 251, pp. 318–319.

oat-breeding work of this Bureau; a brief outline of this plan is given below.

The seed from the individual heads is planted the first year in rows 5 feet long and 1 foot apart. If a considerable number of rows are planted, it will be found convenient to run them in three series, with a narrow space between the series, as shown in the diagram (fig. 1). If weeds are numerous, one or two hoeings may be necessary. At harvest time the plat should be gone over carefully, and those rows which appear to be low in yield, or are particularly subject to lodging, disease, or undesirable qualities of any kind, should be discarded. Those of outstanding value should be harvested and thrashed separately, and retained for further testing.

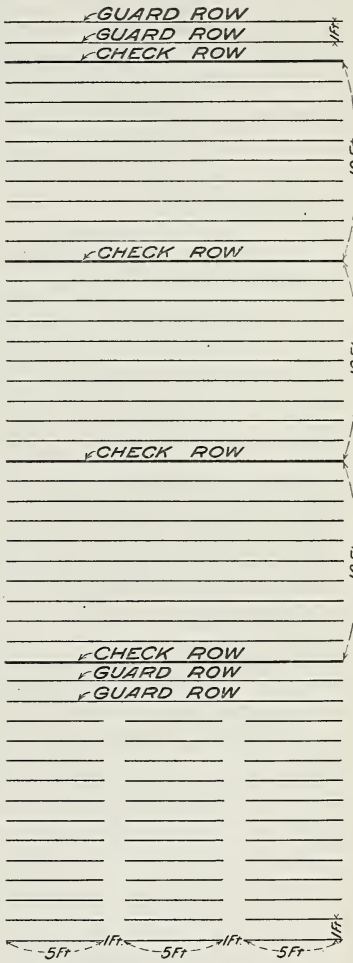

FIG. 1.—Diagram showing the planting plan of seed plat for the improvement of oats by individual plant selection.

The next year the seed from these rows should be planted in rows 17 feet long and 1 foot apart, planting every tenth row of a standard variety or of the bulk seed from which the original selections were made, for comparison and for the detection of soil variations. Each of the short rows of the preceding year should have produced enough seed for two or more of these 17-foot rows. The several rows of any particular strain should be planted in different parts of the plat so as to equalize any variation in the soil. Their location should be carefully noted, so that they may be compared with each other and the seed combined after harvesting and weighing. These 17-foot rows contain approximately one-sixteenth of a square rod, or $\frac{1}{256}$ of an acre. At a common rate of seeding in sections where oats are an important crop, $2\frac{1}{2}$ bushels to the acre, one-half ounce is sufficient for one of these 17-foot rows. At harvest time the plat should again be carefully studied and only the most promising strains retained. Each row should then be harvested, thrashed, and weighed, and the weight recorded.

The test the third year is along similar lines. Two or more 17-foot rows should be planted of each of the strains which yet remain, and the check rows should be used as before. In addition, however, plats should be planted of several of the most promising strains, so that they may be increased as rapidly as possible. At harvest time discards should be made as in previous years, and the remaining rows and plats should again be harvested, thrashed, and weighed. The number of strains should now be considerably reduced, and by comparison of the previous records with those of this year and the discarding of those strains which do not show up well a further reduction can be made.

The fourth year the few remaining strains are again tested as before, and plats of considerable size should be planted of those with the best records. After the harvest of this year, all should be discarded except those of outstanding excellence. These best strains should now be in sufficient quantity for field tests, and if of real value should be distributed to neighbors and tested under varying conditions to demonstrate their general adaptability. If the strain proves its excellence over a considerable area, a name should be given it, to prevent confusion with other varieties.

New strains selected either from the general crop or from the row tests may of course be introduced at any time by starting them in the 5-foot rows and adding them to the general series of 17-foot rows the following year.

The diagram (fig. 1) shows, in the upper portion, the 17-foot "progeny" rows for comparison of strains, with the two "guard" rows and a "check" row at each end of some standard variety, and every tenth row from the first check a check row. The lower portion shows these 17-foot rows divided into three 5-foot rows with alleys 1 foot wide for the planting of the individual selections. It is from these rows that the strains are taken in succeeding years to the progeny rows.

A permanent record should be kept of the different strains. This record should show the essential facts regarding the performance of a given strain from the time the original selection is made. For convenience, each selection should be given a number, and the number should be retained until the strain is discarded or given a permanent name as a variety worthy of distribution. If selections are made from any of the strains they should retain the original number and be given a second selection number as well. Thus, if selections are made from strain 25 they should be designated as 25–1, 25–2, 25–3, etc. If several varieties are used, either the name of the variety should be used with the selection, or the variety should be designated by a number which precedes the selection num-

ber. Thus, we may have Silvermine 1, Silvermine 2, etc., or 1–1, 1–2, etc. In this latter case the first figure of each couple designates the number of the variety, and the second figure the selections of that variety. Selections of variety No. 2 would be numbered 2–1, 2–2, etc. The sample page from a notebook shown as Table I, which can be made by ruling vertical columns on ruled paper, illustrates the system of numbering and the essential notes which should be taken each season on all the selections. These notes should be kept in a permanent cover, such as the loose-leaf binders which are usually obtainable at stationery stores.

TABLE I.—*Record of oat selections for 1908.*

Selection number.	Row No.	Date.				Resistance to—			Yield of grain.	Quality.
		Planted.	Came up.	Headed.	Ripened.	Rust.	Lodging.	Shattering.		
						P. ct.	*P. ct.*	*P. ct.*	*Oz.*	
114	519	4–3	4–14	6–12	7–10	80	90	100	14.5	No. 2.
114–1	520	4–3	4–14	6–12	7–10	85	98	100	15	No. 2.
Check	521	4–3	4–14	6–14	7–11	80	95	100	13	No. 2.
114–3	522	4–3	4–14	6–12	7–10	85	80	100	12	No. 2.
114–5	523	4–3	4–14	6–13	7–10	75	75	100	14	No. 2.
115	524	4–3	4–15	6–15	7–14	75	80	95	15	No. 3.
115–1	525	4–3	4–15	6–15	7–14	75	80	95	12	No. 3.
115–4	526	4–3	4–14	6–15	7–14	75	70	98	15	No. 3.
115–4–1	527	4–3	4–14	6–15	7–14	85	90	100	16.5	No. 2.
118	528	4–3	4–14	6–12	7–10	95	99	95	14	No. 2.
119	529	4–3	4–14	6–12	7–10	90	80	95	11	No. 3.
120	530	4–3	4–14	6–15	7–12	80	60	100	10	No. 3.
Check	531	4–3	4–14	6–14	7–11	80	95	100	14	No. 2.
120–1	532	4–3	4–14	6–15	7–12	80	75	100	10.5	No. 3.

As shown in the above table the rows of the plat are numbered consecutively, with every tenth row as a check. Selection 114 and three selections from it were planted, 1, 3, and 5. This indicates that selections 2 and 4, and selections of this strain bearing higher numbers than 5, have been discarded in previous years. Of strain 115 we have two selections, 1 and 4, and a reselection of 4, recorded as 115–4–1. No further selections have been made of strains 118 and 119. The selections which have the numbers 116 and 117 have been discarded.

All dates are recorded by figures representing the month and day of the month. Thus, the date of planting was 4–3, or April (the fourth month) 3. Resistance to rust is recorded as the percentage of freedom from this disease. Resistance to lodging and shattering are entered in like manner. Selection No. 114–1, which lodges very little, is marked 98 per cent resistant, while 114–3, in which there is considerable lodging, is given only 80 per cent. The yield is recorded as ounces of thrashed grain to the row. Quality may be indicated by the market grades No. 2, No. 3, etc., or by percentages.

HYBRIDIZATION.

Few hybrid varieties of oats have yet been produced, practically all of the work of improvement having been accomplished by selection. Hybridization of the small grains is comparatively difficult, and the problem of selection so complicated that the farmer is hardly justified in attempting to hybridize. For the present at least, while there is so much to be accomplished by selection, his efforts can well be confined to that field, leaving the hybrid problem to the professional breeder.

VARIETIES.

A brief list of the varieties which are most likely to lend themselves to efforts toward their improvement follows. Many others might be mentioned.

For fall sowing in the South: Virginia Gray and hardy strains of Rustproof.

For spring sowing in the South: Burt, Rustproof.

For the Central States (from Pennsylvania westward to Colorado): Sixty-Day, Kherson, Silvermine, Joannette, Early Champion, Siberian.

For the Northern States (including the intermountain area and Pacific Northwest): Swedish Select, Early Gothland, American Banner, Lincoln, Progress, Sixty-Day, White Russian, Ligowo, Big Four.

CONCLUSIONS.

The unsatisfactory yield and quality of the oat crop in recent years show the necessity for the improvement of this grain. This improvement may be along the lines of disease resistance, strength of straw, earliness, quality, or yield, or several of these may be combined. In any event, yield is the essential basis of selection. Mechanical selection and the introduction of seed from foreign countries or from sections more favorable for the production of the oat crop are but temporary makeshifts. The use of the seed plat usually gives good results, but permanent improvement is best effected by pedigreed strains produced from individual plants. A large number of these selections should be made and tested, the poorer ones discarded, and the very best increased as rapidly as possible. Where one of the pedigreed strains proves of exceptional value it should be widely tested and eventually named and introduced as a new variety. At present the farmer is advised to leave hybridization of the small grains to the professional breeder.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *April 24, 1909.*

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